US-PAT-NO: 5015097

DOCUMENT-IDENTIFIER: US 5015097 A
See image for Certificate of Correction

TITLE: Method for inspecting filled
state of via-holes filled
                          with fillers and apparatus
for carrying out the method

DATE-ISSUED: May 14, 1991

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Nomoto; Mineo	Yokohama	N/A	N/A	JP
Ninomiya; Takanori	Hiratsuka	N/A	N/A	JP
Koshishiba; Hiroya	Yokohama	N/A	N/A	JP
Hamada; Toshimitsu	Yokohama	N/A	N/A	JP
Nakagawa; Yasuo	Chigasaki	N/A	N/A	JP

US-CL-CURRENT: 356/314, 356/237.5 , 356/237.6 ,
382/150

ABSTRACT:

   A method for inspecting the filled state of a
plurality of via-holes which
pass through a non-conductive circuit board and are
filled with a conductive
substance and an apparatus for carrying out the
method are disclosed.

The surface of the circuit board is illuminated in two directions to
generate shadows depending on the concave or convex state of the fillers in a
plurality of via-holes. An optical image of the illuminated surface of the
circuit board is detected. Each edge of the two shadow areas, which exist in
the detected optical image and are generated in one via-hole by light
irradiation in two directions, is detected. Whether the filler in this one
via-hole is in the concave state or convex state is identified according to the
mutual position relationship of the detected edges. The length of each shadow
area is detected, and whether the concave state or convex state of the filler
is within a predetermined allowance is decided according to the detection
results. The area of the image of the filler is detected according to
differences between the brightness of the board surface or of the via-hole wall
and the brightness of the filler in the via-hole in the detected optical image,
and whether the filler is lacking or not is decided according to the detection
result.

18 Claims, 30 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 16

----------- KWIC ---------

Detailed Description Text - DETX (9):

In the apparatus with the configuration mentioned above, a detected image signal is inputted to the shading correction circuit 17, 18, or 19 to correct uneven illumination or uneven sensitivity of line sensor 13a, 13b, or 13c. The shading correction circuits 17, 18, and 19 are, for example similar to the one indicated in Japanese Patent Application Laid-Open No. 58-153328. The shading-corrected image signal is binarized by the binarizing circuit 20, 21, 22, or 23 according to the binarizing threshold value VH_2, VH_1, or VH_3. The binarizing threshold values can be determined as follows. From the image signal detected as shown in FIG. 5(a), the frequency distribution is determined as shown in FIG. 5(b). A signal level H_{max} indicating the brightness of the green sheet surface and a signal level H_{min} indicating the brightness of the filler are determined from the distribution curve. The binarizing levels VH_1 and VH_2, which are threshold values, are determined by executing operations according to those output data. These operations are performed by **histogram** generation circuits 24, 25, and 26 and the microcomputer 27 shown in FIG. 1. These binarizing levels may be determined with a green sheet to be inspected before **starting the automatic** inspection.